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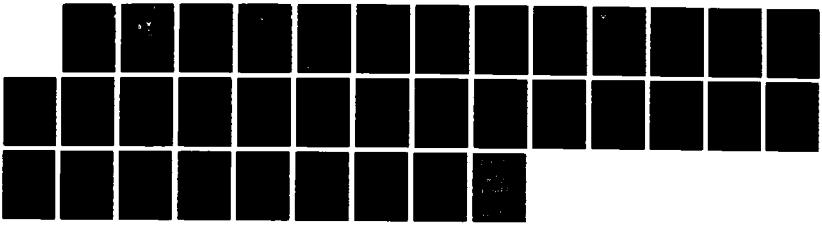

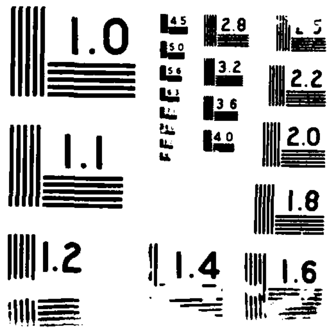
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STUDENT REPORT

COST MANAGEMENT--REFORM NOW!

Major Garry C. Varney 88-2670

"insights into tomorrow"

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REPORT NUMBER 88-2670

TITLE COST MANAGEMENT--REFORM NOW!

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The manufacturing environment within the defense aerospace industry is changing. This change, resulting from increased automation, changing cost trends, and changing DOD acquisition policies, is forcing industry to employ new methods of cost management to effect better control and planning of weapon system cost and capital expenditures. Present direct labor-based accounting systems are inadequate in an automated environment in assisting management in product costing/pricing, cost containment, and investment decision-making since direct labor is yielding to indirect costs as the product's significant cost driver. To compete and grow in the future, industry must rethink their cost management practices. The Westinghouse Advanced Cost Management System (ACMS) is one of the first conceptual designs of a modern system which addresses cost management needs in the automated factory. Industry and DOD must work jointly to build on the ACMS concepts and quickly implement a system which will allow for better control of defense spending.

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PREFACE

The intent of this report is to inform the Air Force acquisition community about an important cost management problem in the defense aerospace industry. The intent is not to make the reader an expert in either direct labor-based accounting or the Advanced Cost Management System (ACMS) developed by Westinghouse Corporation. Instead, this report focuses on how direct labor-based cost systems affect product pricing/costing, cost containment, and management decisions and how an advanced system can better assist management in these areas.

The Air Force Systems Command became acutely aware of the shortcomings of a direct labor-based cost system in the early '80s through its experiences in the Industrial Modernization Incentives Program (IMIP) and through a joint government-industry industrial base study termed, "Production Base Analysis '84: Blueprint for Tomorrow," sponsored by the Aeronautical Systems Division. In addition to the IMIP and Blueprint for Tomorrow, several factors have converged over the past decade to focus our attention on the challenges facing the defense industrial base. The nation's economic condition, international competition, the need to improve product quality, low productivity, and rising defense system acquisition costs present unparalleled opportunity as well as challenges to both industry and government decision-makers. A major key to successfully meeting these challenges will be the ability to effectively and efficiently manage costs. To manage costs to the degree required in today's competitive environment, industry and government alike must set aside "old ways" and engage in a cooperative program charted to make substantive changes in present cost management practices.

I want to express my appreciation to Mr. Don Aaby, Deputy Director, Contract Management, Headquarters Air Force Systems Command, and Major Scott Allen, my faculty advisor, for assisting in the preparation of this project.

ABOUT THE AUTHOR

Major Garry Varney graduated from the Virginia Military Institute with a bachelor's degree in economics. Upon graduation, he received a commission in the U.S. Air Force and was assigned to the Armament, Development, and Test Center (ADTC) at Eglin AFB, Florida, as a base contracts negotiator. After serving in base contracts for one year, he was assigned to the Research and Development Contracts Division at ADTC as a contract negotiator responsible for the development of business strategies, contract negotiations, and contract award for numerous R&D programs in support of the Armament Laboratory. After a tour in Turkey as the Administrative Contracting Officer for the Turkish Base Maintenance Contract, he was assigned to the F-16 System Program Office as a foreign military sales contracts manager responsible for developing business strategies and conducting negotiations for the Pakistani and Venezuelan F-16 buys. While stationed at Wright-Patterson AFB, Ohio, he was assigned as Chief, Central Technology Modernization Contracting, responsible for all contract and business strategy policy for the Aeronautical Systems Division's Industrial Modernization Incentives Program (IMIP). His next and last assignment prior to Air Command and Staff College was at Headquarters Air Force Systems Command, first as Special Assistant for Contract Policy, then as the Executive Officer for the Deputy Chief of Staff for Contracting.

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REPORT NUMBER 88-2670

AUTHOR(S) MAJOR GARRY C. VARNEY, USAF

TITLE COST MANAGEMENT--REFORM NOW!

I. Problem: The manufacturing environment within the defense aerospace industry is changing. This change, resulting from increased automation, changing cost trends, and changing Department of Defense profit, competition, and progress payment policies, is forcing industry to employ new methods of cost management to effect better control and planning of weapon system costs and capital expenditures.

II. Data: A second industrial revolution is occurring in the aerospace industry that is dramatically affecting traditional management practices. This second industrial revolution, like the first, is creating quantum leaps in industrial productivity. This increased productivity is accomplished through the employment of sophisticated computer integrated manufacturing (CIM) assisting productivity enhancing equipment such as robotics and flexible manufacturing systems. "[CIM is] the utilization of computers and various advanced manufacturing techniques to perform or assist in the activities necessary to manufacture an item" (6:Glossary). A major effect of this enhanced productivity is a fundamental change in cost trends. No longer is direct labor the significant cost driver within the factory. With the replacement of direct labor by machines, a traditional manufacturing overhead cost, a significant portion of factory costs is hidden from management's direct control. As a result, direct labor-based cost systems, developed when direct labor was a large percentage of total costs, have

CONTINUED

become ineffective as a management tool for pricing defense contracts, containing product cost escalation, and making long-term investment decisions.

An advanced cost management system capable of providing management with timely and accurate information is required in an automated factory. This new system must be able to accurately price products, timely collect and report cost performance to allow for cost control of products, and accurately evaluate, select, and track investment technologies. This means the cost management system should be capable of identifying and tracking significant product costs, monitoring technology costs as well as labor costs, performing accurate and timely reporting of significant cost variances, and performing accurate investment analysis and cost benefit tracking. Through an Air Force contract, the Westinghouse Corporation has developed a cost management system conceptual design that meets these requirements.

III. Conclusions: Automation, cost trends, and Defense Department policies have forced defense aerospace industry management to reassess their cost management practices. Cost control is the key to future survival in this era of austere budgets, DOD and Congressional scrutiny of defense spending, and growing weapon system costs. The key to cost control is the implementation of a cost management system that addresses the future factory environment. Such a system has been conceptually developed. It is now up to the DOD and industry to work in cooperation to ensure these advance cost management systems are implemented expeditiously, efficiently, and with minimal impact to the existing weapon system programs being produced within the factory.

Chapter One

COST MANAGEMENT ISSUES

INTRODUCTION

Price Waterhouse, a big-eight accounting firm, defines cost management as,

> . . .the planning and control of product development and product manufacturing costs throughout an item's life cycle. However, cost management is consistently more than simply capturing and reporting historical cost performance. It is the use of costs. . .to plan, measure and control product development, material management, and product management activities. More importantly, it is the measurement and control of performance, or productivity, and the identification of opportunities for improvement (8:5).

> . . .the primary objective of a cost management system should be to guide the reduction of product costs. [To do this], it is necessary to provide cost information in such a way as to pinpoint the functional responsibilities for cost and for performance (8:16).

A cost management system should be integrated into the entire operational system of a corporation and provide information for four management needs: product costing/pricing, cost containment, and long-term decisions, and inventory valuation/pricing (6:Preface). Unfortunately, most of the systems used by defense contractors to account for and manage costs were developed many decades ago. These systems were shaped by market and business conditions different from those today. These systems were designed when direct labor was a substantial portion of total product cost and could easily absorb overhead costs without obscuring the true product cost. Changes in the defense acquisition environment and changes in manufacturing techniques with the employment of robotics, computer-aided design (CAD), and flexible manufacturing systems (FMS) have increased the complexity of defense contract cost management systems and have created the need for a new approach. "[Automation of the factory floor has] resulted in higher overhead rates and a shrinking base of labor over which to allocate those costs" (7:1). As a result, management's ability to control costs has been greatly obscured.

DEFENSE VS. COMMERCIAL INDUSTRY

Traditionally, defense industry management does not concern itself with cost containment to the degree of its commercial counterpart in a purely competitive or oligopoly market. There are several reasons for this mindset. First, defense contractors earn profit based on a percentage of allowable cost incurred within the pricing structure of the contract. Profits, therefore, increase as costs increase up until the contractor has reached the negotiated targets of the contract. There is no incentive to modernize the factory if savings realized through enhanced productivity would be taken away by the Government. In commercial industry the opposite is true. Given the market price of a product is stable, a commercial business firm earns more profit by controlling manufacturing costs.

Secondly, price historically has not been the driving factor in the award of defense weapon system contracts. Technical design has always been the significant factor in determining the winner. Price comes into play only when competing designs prove equally acceptable. In commercial industry the opposite is true in most cases. The consumer is always looking for the "best" price as long as the product satisfies the consumer's quality requirement. So, computer companies like IBM and Apple are constantly trying to design the most technically advanced computer at the lowest price.

Lastly, after contract award, defense industry traditionally does not have to concern itself with further competition of that product. In the absence of competition, the contractor does not have to continually accommodate change and, in many instances, charges monopolistic prices for the change. Conversely, commercial industry in a competitive or oligopoly marketplace constantly anticipates change to continue to maintain or increase its share of the market. Fortunately, this mindset is changing within defense industry due to automation advancements, government policy shifts, and discouraging cost trends which have aroused the concern of management.

EMERGING ISSUES

Several issues have emerged in the past five years that have caused industry management to evaluate the effectiveness of their cost management practices. The first issue is the advancement in factory automation. On October 8, 1987, a front page Wall Street Journal article entitled, "Antique Arsenals: Many Defense Contractors Make High-Tech Gear in Low-Tech Plants, Raising Cost," best describes this issue:

> . . .Supporters hope that the programs [IMIP] will save taxpayers billions of dollars and help strengthen the defense industry. So far, the Pentagon claims overall savings of close to $1 billion from the programs. The Air Force, which has taken the lead, expects to save $6 billion over the next five years. . .
>
> For example, modernization projects at General Dynamics Corp's F-16 fighter plant have so far saved $261 million as a result of $51 million in government seed money and a $175 million capital investment by the company. . .

> Grumman found similar problems at its F-14 fighter plant in Bethpage, N.Y. Aided by $9.4 million in Navy funds, it found not only outdated machines but also a lot else crying out for change. Grumman was cutting and drilling some sheet-metal parts in three separate plant locations. And it was working as it had for 30 years-almost entirely by hand. After tracing a part's pattern onto aluminum sheets, workers would guide them through 30-year old bandsaws, and then any required holes would be drilled manually.
>
> . . .Now two white smocked technicians tend two enormous $1.5 million machines that automatically cut, drill and trim aluminum sheets. Computers eliminate waste by nesting 10 parts on a four-foot-square sheet. The parts cost half as much to make as before. . .(4:1,20).

As a result of these automation trends throughout the aerospace industry, labor costs are becoming less and less significant to the overall product cost. Manufacturing overhead costs such as capital equipment, depreciation, and machine maintenance are becoming more and more significant to the overall product cost.

The second emerging issue that has affected how industry addresses cost management is the recent policy shifts by the Department of Defense (DOD). Regarding new policy in the DOD, just three will be mentioned: reduction in progress payments, revised profit policy to emphasize investment and de-emphasize cost, and a move toward more second sourcing of major systems.

"On May 1, 1985, the Secretary of Defense lowered the customary progress payment rates for large business to 80%, for small business to 90%, and increased the required contractor investment under optional flexible progress payments to 15%" (5:IV-5). This was from a previous percentage of 90% and 95%, respectively. This reduction in progress payment rates equated to a reduction in government cash outlays by approximately $2.1 billion in FY 85, alone (5:IV-6). This $2.1 billion is not contract savings, but a cost avoidance on the part of the government. The burden of financing this cost now rests on the shoulders of industry--a perfect incentive for industry to better manage their costs since this change can affect profit margin.

The profit policy of the DOD has evolved over the decades with its basic premise that, ". . .[profit] should depend on the risk assumed by a contractor, the difficulty of the task, the amount of contract costs. . ., and other factors" (5:V-1). The primary fallacy of this approach is if profits are a function of costs, the higher the costs the higher the profits in actual dollars, not percentages. The contractor, therefore, was not obliged to concern himself with ambitious cost reduction programs such as automation of the factory or containing overhead expenses. The DOD modified the profit policy to reward profit on assets employed based on their contribution to productivity, allow imputed interest on all capital employed including working capital, and structure a risk and capital preference reward for buildings and machinery/equipment with more profit going to investments in cost-reducing projects (5:V-59-60). At the same time, the profit policy would decrease the amount of profit awarded based on contractor cost.

The third and last DOD policy shift that affects the degree to which contractors must manage costs is the policy of second sourcing. As late as 1980, the practice of establishing a second production source was mainly for national security reasons, i.e., two hot production lines for enhanced surge capabilities. Now, however, the DOD is second sourcing major programs such as the Alternate Fighter Engine, AMRAMM, and any program where major cost reductions can be realized as a result of price competition. Defense industry management must now concern itself with competition throughout the life of the program buy. Costs now become a legitimate management concern.

The last emerging issue to be discussed that causes concerns in cost management is changing cost trends. Figure 1 is a good illustration of changing cost behavior patterns as production lines automate with productivity enhancing equipment, Just-In-Time (JIT) inventory, computer integrated manufacturing (CIM), and computer integrated engineering (CIE). The chart shows that as the factory automates, inventory and direct labor costs decline in real terms and in percentage of product cost. Likewise, engineering and technology costs increase. As a result, there is a major shift from variable costs (direct labor) to fixed costs (technology) as demonstrated in Figure 2.

SUMMARY

This chapter summarized some of the major issues facing the aerospace industry today in terms of impact on cost management. The aerospace industry is strapped with an accounting system developed over the past three decades which is totally inadequate in today's automated factories. It is a system which focuses on direct labor to control costs when the overwhelming percentage of costs lie in overhead and material accounts (See Figure 3). It is a system developed during a time when cost controls were not a major factor in the decision-making process. Only recently have government and market pressures focused management's attention on cost containment. To get a better understanding of how inadequate a direct labor-based system is in an automated environment, the next chapter will detail how direct labor-based systems affect management's ability to price and cost products, control costs, and make sound investment decisions.

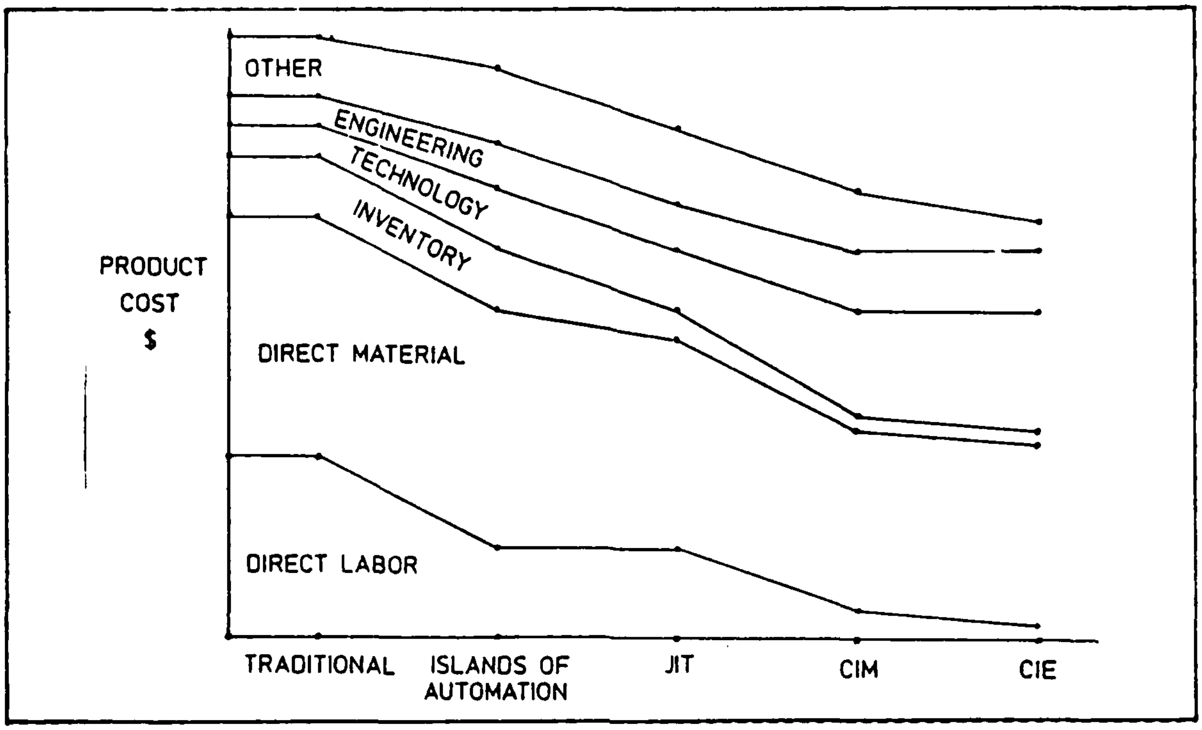

FIGURE 1: CHANGING COST BEHAVIOR PATTERNS (7:--)

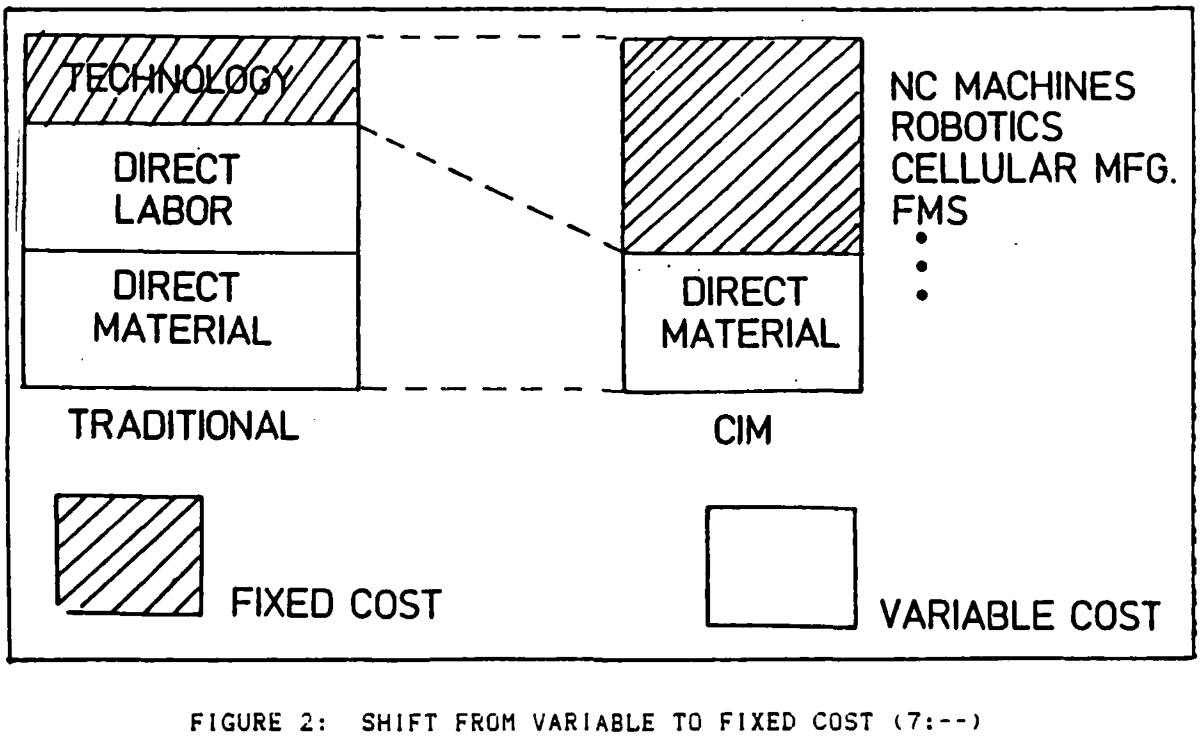

FIGURE 2: SHIFT FROM VARIABLE TO FIXED COST (7:--)

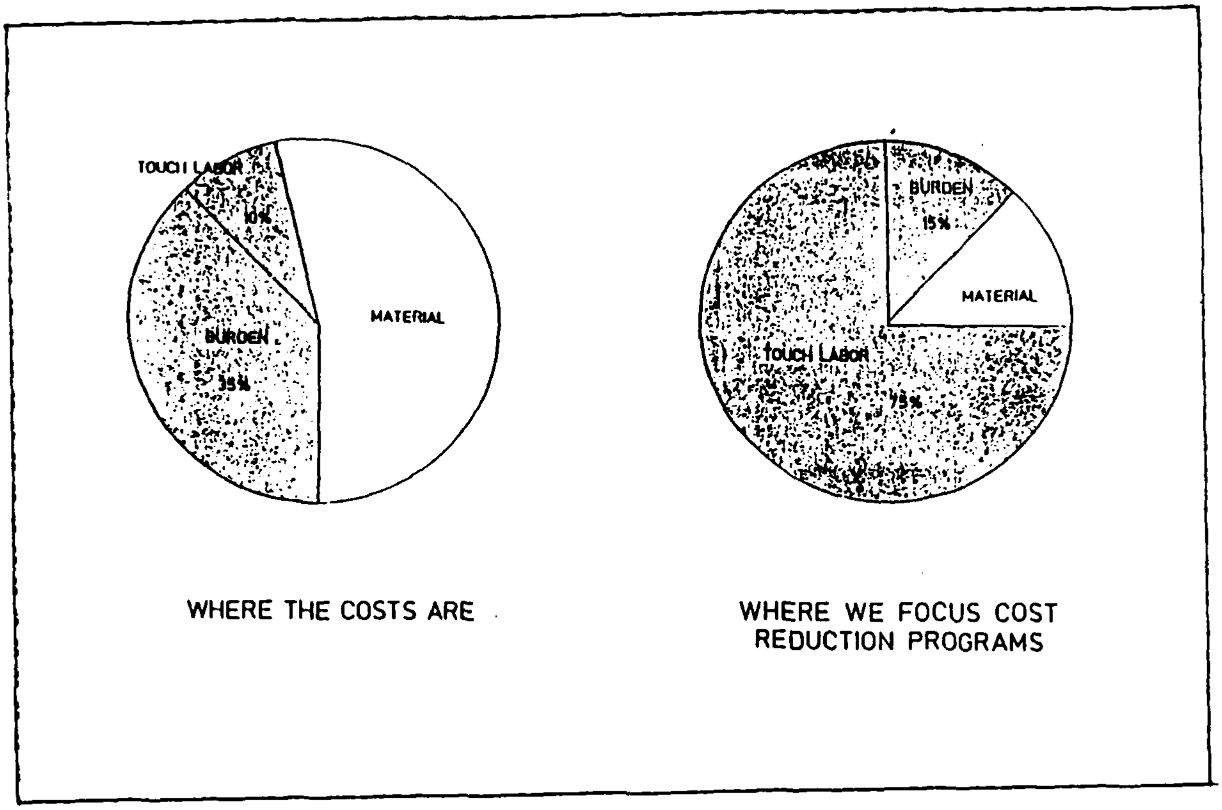

FIGURE 3: ACCOUNTING SYSTEMS INFLUENCE BEHAVIOR (7:--)

Chapter Two

DIRECT LABOR-BASED COST MANAGEMENT SYSTEM

PRODUCT COSTING/PRICING EXAMPLE

Chapter One highlighted several issues facing defense industry management operating under a direct labor-based accounting system: increasing overhead rates, shrinking base of direct labor over which to allocate costs, increasing fixed costs, and decreasing variable costs. This chapter will illustrate by example how such a system distorts product costing, hinders management's ability to contain or reduce costs, and affects the decision process for capital investments.

"TRACEABLE COSTS"

	PRODUCTS A	PRODUCTS B
LABOR	$ 50	$200
MATERIAL	300	300
MATERIAL OVERHEAD	50	50
MANUFACTURING OVERHEAD	525	375
TOTAL PRODUCT COST	$925	$925

$$\text{MANUFACTURING OVERHEAD RATE CALCULATION} = \frac{\text{MANUFACTURING OVERHEAD}}{\text{LABOR COSTS}} = \frac{\$900}{250} = 360\%$$

TABLE 1: PRODUCT COSTING (7:--)

In the Table 1 example, assume the ABC Company produces two products: Product A and Product B. Product A is very dependent on technology to produce. Product B is very dependent on direct labor. To allocate overhead in a direct labor-based system, divide total labor costs into total manufacturing overhead costs which consists of depreciation of the equipment, equipment maintenance, etc. In this example, the "factory" labor overhead rate is 360%. This means that for every dollar of labor charged to Product A or Product B, $3.60 of overhead will be allocated to that product.

According to the "traceable costs" (costs that are directly attributable to that product), both products cost the company $925.00 to produce. The following illustrates how, under a direct labor-based cost system, these products would be priced to a customer.

	PRODUCTS			
	A		B	
LABOR	$ 50		$200	
MATERIAL	300		300	
MATERIAL OVERHEAD	50		50	
MANUFACTURING OVERHEAD	180	(50X360%)	720	(200X360%)
TOTAL	$580		$1270	

TABLE 2: CALCULATED COSTS (7:--)

As is illustrated in Table 2, Product A is grossly underpriced in terms of actual costs to produce at the expense of Product B which is grossly overpriced. In fact, there is a 37% error in costs of both products ($1270-$925=$345; $580-$925=$-345). If both products competed in a competitive market, sales of Product A should skyrocket; whereas, Product B should be forced out of the market.

The bottom line of the above illustration is direct labor-based cost systems are unable to focus on the true costs of a product since the bulk of the costs are hidden from management's eyes in indirect overhead accounts. In other words, management is not focused on the significant cost elements (See Figure 3). For the ABC Company, management is focused on two direct costs, labor and material, while on 55% of the product cost management has no detailed information to exercise responsible control. "The greater the overhead-to-direct labor rate, the greater the likelihood for product cost distortion. . ." (3:37).

COST CONTAINMENT

In a majority of today's markets, cost containment and, in fact, cost reduction is critical for survival. The following statement provides statistical support for the above statement: "The need for product cost reduction is a driving force in commercial electronics' manufacturing. Unless the price performance ratio of a product can be maintained at a 20% improvement per year, an organization risks significant market erosion" (6:II-4).

Recognizing the need to better manage costs on defense weapon systems programs, a coalition of Air Force, other government agencies, defense

industry, and professional accounting companies organized a project in 1986 to address cost management issues. CAM-I, the contracted manager of the coalition, issued a preliminary report which stated:

> . . .Today's managers are making decisions in complex, technology-driven situations where the information supplied by their internal management system is inadequate and often misleading.
>
> Existing cost accounting systems and cost management practices do not adequately support the objectives of automated manufacturing because they: are plagued by high overhead rates due to inadequately traced costs; do not isolate the costs of unnecessary activities. . .; do not adequately identify and report the cost of quality deficiencies in products or processes; focus on controlling the production process while significant costs determined at the design and development phases of a product's life cycle are inadequately identified. . .(7:2).

To illustrate, the following product cost build-up shows the degree to which ABC management has visibility into the cost of Product A and, therefore, cost control over the product. In this breakout of costs, note not only the dollar magnitude of the costs outside the visibility of management, but also note their type, as well. Major cost drivers in an automated factory can include depreciation of capital equipment, maintenance of that equipment, utilities, and management information systems.

PRODUCT COSTS VISIBLE TO MANAGEMENT

Purchased Parts	+	Process Routing	=	Production Cost
Material Costs	$225	Set-Up Labor	$ 5	$350
Freight	75	Production Labor	30	
	$300	Test/Inspection	5	
		Rework Labor	5	
		Quality Labor	5	
			$50	

HIDDEN COSTS

Material Overhead	$50	Manufacturing Overhead	$525	$575
Purchasing		Depreciation		$925
Payables		Maintenance		
Receiving		Utilities		
Inspection		Software		
		Tooling		
		Manufacturing Engineering		
		Industrial Engineering		

TABLE 3: FLOW OF "PRODUCT A" COST BUILD-UP

INVESTMENT DECISION

As was illustrated in the previous sections, direct labor-based cost accounting systems are not focused on significant product costs; therefore, ". . .[the ability of management to decide on long-term capital improvements in the form of automation] has been impeded by [management's] inability to relate key production activities to their cost drivers, and to relate these cost drivers to their appropriate costs" (9:44). In addition to the accounting system's inability to accurately measure the benefit and cost effects of an investment, typical measures of acceptability for a capital investment are flawed, especially when payback periods are used.

To illustrate this point, let's assume the ABC Company is studying an investment in a new numerically controlled (NC) machine center for Product A production. The following applies:

INVEST: NEW NC MACHINE CENTER
ASSUME: 100,000 UNITS [OVER FIVE YEARS]
$2.5M INVESTMENT
5 YEAR RECOVERY [STRAIGHT LINE DEPRECIATION]
$20/HR LABOR RATE
1/2 HR/UNIT DIRECT LABOR SAVINGS

	A	B
LABOR	$ 40	$ 200
MATERIAL	300	300
MATERIAL OVERHEAD	50	50
MANUFACTURING OVERHEAD	550	375
TOTAL	$ 940	$ 925

NEW MANUFACTURING OVERHEAD RATE = $\frac{\$925}{\$240}$ = 385%

REVISED CALCULATED COSTS

	A		B	
LABOR	$ 40		$ 200	
MATERIAL	300		300	
MATERIAL OVERHEAD	50		50	
MANUFACTURING OVERHEAD	154	(40X385%)	770	(200X385%)
TOTAL	$544		$1320	

TABLE 4: NEW PRODUCT COST BEHAVIOR PATTERN (7:--)

The Air Force, in conducting the Industrial Modernization Incentives Program, discovered in many instances, defense industry makes final investment decisions based on financial and risk analysis in conjunction with a strict payback period to determine the corporation's investment hurdle rate. A corporate hurdle rate is that return on investment rate which an investment must exceed before the corporation will consider financing the project. Payback period is a time value, typically in years, in which an investment must achieve the corporate hurdle rate. A typical payback period is between two and four years. To illustrate these definitions, the ABC Company would invest in the NC Center if cash flow from the investment exceeds, by a specified percentage, the initial investment cost to include the financing cost (cost of money) plus a profit percentage based on risk, all within the payback period. This investment policy has several drawbacks. First, management's refusal to look beyond the payback period precludes the possibility of a substantial return on investment as a result of significant cash flows in the later years. Secondly, this approach is strictly based on financial considerations, not addressing the "goodness" of the investment in terms of intangible improvements such as increased quality. Thirdly, in most cases, these investment decisions are stand alone decisions and not part of an overall capital investment plan for the company.

In the above example (Table 4), assume the ABC Company's hurdle rate is 20% and its payback period is three years. The ABC Company would disapprove this investment because it failed to generate the required rate of return within the payback period. This is unfortunate because the rate of return in years four and five more than offset the low returns in the early years making this a viable long-term investment.

YEAR	1	2	3	4	5
PRODUCTION	5000	10000	20000	35000	30000
PRESENT VALUE NET INCOME AFTER TAX*	$ 260	$ 260	$ 240	$ 310	$ 260
ASSET BASE*	$2,500	$2,000	$1,500	$1,000	$ 500
RETURN ON INVESTMENT	10%	13%	16%	31%	52%

PAYBACK PERIOD OF ABC COMPANY = 3 YEARS
REQUIRED RETURN ON INVESTMENT = 20%
* ALL DOLLARS ($) IN THOUSANDS
ASSEST BASE = UNDEPRECIATED VALUE OF INVESTMENT (ASSET)

TABLE 5: FORECASTED 5-YEAR AFTER-TAX CASH FLOW

According to Mr. Richard L. Engwall, IMIP Program Manager at Westinghouse Electric Corporation, Baltimore, Maryland,

> Companies have traditionally invested in projects with short-term payoff periods (i.e., less than 2 years) to manage the bottom line. The U.S. financial system fosters this short-term mentality. . .companies feel that they cannot afford to sacrifice short-term profits for investments in the future. . .
>
> In addition to their reluctance to invest in long-term projects, companies are also attempting to maximize the return on their investments without a structured approach for identifying non-value added costs and cost drivers. With the exception of certain major plant and product line investments, a comprehensive analysis has not been undertaken. Most of today's cost management systems do not provide the information needed for such an analysis (2:56).

In addition, a comprehensive monitoring program to track the benefits of the investment is just as important as the initial analysis. A viable tracking system is important for several reasons. First, it monitors the implementation schedule to ensure the equipment becomes operational. Secondly, once operational, savings can be tracked by evaluating the performance of the new equipment against the standards of the old system. Third, tracking after implementation allows management to ensure optimum utilization of the investment. Unfortunately, as Mr. Engwall states, "Other deficiencies found in existing investment management systems include. . . methodologies for evaluating investments in advanced manufacturing technology and for monitoring the benefits of such technology do not exist" (2:56).

SUMMARY

In the above illustrations, management cannot control at the product level those costs not directly associated with the product, i.e., indirect overhead costs. As a result, cost containment and long-term investment decisions become critical issues. In an automated environment, direct labor costs become an insignificant cost driver compared to traditional indirect costs such as depreciation. Therefore, if management wants to control costs at the product level and calculate accurate benefit and cost effects of an investment, one of two things must occur. Either continue the direct labor-based cost system and maintain a labor intensive production line, or enhance the cost system to discretely allocate traditional indirect overhead costs directly to the product.

Chapter Three

ADVANCED COST MANAGEMENT SYSTEM

INTRODUCTION

As discussed in Chapter One, several emerging issues now cause industry management to turn their attention to cost management. These issues include factory automation, changing Government policies toward profit, competition, and progress payments, and the changing cost trends towards greater overhead costs away from the direct labor costs. It is evident from the example in Chapter Two the direct labor-based cost systems are no longer adequate to meet the challenges of the emerging issues. Fixing the system, however, is not an overnight task. A Harvard Business Review article by three Price Waterhouse management advisors sums it up,

> . . .Fixing an obsolete cost system, however, is not a simple task. No other system has such a pervasive effect on a company. Cost accounting is based on budgets and forecasts; it is entwined with the material control systems; it provides informa- tion for financial reporting; it influences pricing and marketing strategy; and it is the source of information for make-or-buy decisions, certain capital expenditure decisions, and performance measurement decisions. Revising the system often takes several years of attention and a good set of blueprints (1:135).

SYSTEM OBJECTIVES

The objectives of a revised system must address the inefficiencies of the direct labor-based system to price/cost the product, contain product costs, and assist in investment decisions. Therefore, the revised system must be able to accurately price the product by identifying the costs associated with that product. Secondly, the revised system should collect and report cost information to allow for both cost and physical control of the product. Thirdly, the system should include a cost-benefit and tracking model that will provide the framework to evaluate, select, and track advanced manufacturing technologies as a portfolio of interrelated projects rather than on a stand-alone basis (1:136; 7:11-12).

The following are key considerations identified by Price Waterhouse which should be included in a revised system:

- The cost management system should serve as a guideline for

cost estimation initially (during product development) and subsequently for updates for product cost standards during the life of the program.

- The cost management system should serve as a methodology for segmenting the program into controllable elements related to major steps of product development, manufacturing and field support.

- The cost management system should serve as a guideline for estimating costs and benefits from changes in product specifications or changes in the program scope, including volume of production changes.

- The cost management system should serve as a methodology for performing product cost reconciliations between periods, based on the major factors impacting the product cost (for example, material price, engineering changes, process changes, labor rate changes, labor productivity changes, overhead spending changes, volume changes, and like).

- The cost management system should carefully segregate various elements of indirect costs into those that are facilities, product, and operation related in order to provide a better basis for their control.

- The cost management system should serve as a guideline for performing needs analysis in capital equipment acquisition studies. Other information should support productivity improvement and make/buy decisions.

- Of key significance, the cost management system must support the tracking of product cost reductions throughout the product life cycle (8:30-33).

SYSTEM OVERVIEW

To illustrate a revised cost management system, this section will use the examples of Westinghouse's Advanced Cost Management System (ACMS) developed in response to an Electronics Systems Division contract (6:--). "The [objective of the Westinghouse effort was] the conceptual design of a cost management system to be utilized in the manufacturing arena of the 'Factory of the Future'" (6:Preface). ACMS addresses four areas, three of which will be highlighted in this section: product cost estimating, cost containment, and investment decision-making.

PRODUCT COST ESTIMATING

To estimate a product's unit cost, ACMS employs a logical sequence of steps. Remember, the system's task is to accurately identify all costs

required to manufacture a given product and to judiciously allocate those costs to the product. To do this in a complex manufacturing environment, the cost system must quantify the cost of each manufacturing process which adds value to the product. ACMS employs a sophisticated system of standards or predetermined estimates of costs (6:V-1). The result is an efficient cost estimating system. To illustrate, let's use the XYZ Company's Product F as an example.

In the first step, the product structure is determined. The product structure is the components that make up the end item. In this example, Product F is a board assembly consisting of the following components: a bare board, a diode, a processing chip, and other components.

In the second step, all manufacturing work centers in the factory develop a budget and standard rates. The manufacturing work centers involving Product F include: draw parts, robotic assembly, manual insert, test/inspect, rework, solder, touch up, and shipping. In accordance with the ACMS:

> On an annual basis, work centers will establish a budget in order to determine the charging rates that will be applied to production as items move through operating steps. . . The budgets include headcount estimates, estimates of total spending in dollars (i.e., direct, indirect and support charges) and a cost factor that will be used to apply costs to production. . .
>
> After the work center budget is established and the cost factors are calculated, these rates are entered into a database of rates, by work center. . . (6:II-59,II-62).

The first standard is pre-established cost factors for each work center. Below are standard cost factors for the manual insert work center:

DESCRIPTION	COST TYPE	DETERMINANT	COST FACTOR
Manual Insert	Total	Labor Hours	$40.00
Manual Insert	Direct Labor	Labor Hours	8.00
Manual Insert	Non-Productive	Labor Hours	2.24
Manual Insert	Conversion Labor	Labor Hours	1.07
Manual Insert	Other Direct	Labor Hours	4.67
Manual Insert	Indirect Costs	Labor Hours	9.33
Manual Insert	Support Costs	Labor Hours	13.36
Manual Insert	Other Support	Labor Hours	1.33

TABLE 6: WORK CENTER STANDARD COST FACTORS (6:II-62)

Note the cost determinant for manual insert is still labor hours. The ACMS determines cost factors based on machine hours, as well.

As a result of the first two steps, the XYZ Company has effectively accomplished three important tasks in determining product cost: one, it now has identified what was once overhead costs, previously hidden to management, and allocated them to specific work centers; two, both direct cost and traditional indirect costs (overhead) now have a standard cost factor for each manufacturing process; therefore, the overhead costs are now direct costs; three, as the manufacturing environment changes to a more automated factory floor, these costs factors can be updated to reflect the change in costs.

In the third step, the parts routing for Product F is established. Now that the factory is divided into work centers with associated cost factors, the next step is to determine which work centers apply to Product F, how many hours, and what type of costs are involved. The following Table illustrates, ". . .[the] standard hours established by the industrial engineers for each type of labor and machine time. The unit of measure is hours per lot or hours per unit" (6:II-63). In this case, these numbers are the standard hours for each unit of Product F.

	STANDARD HOURS/UNIT				
DESCRIPTION	SET-UP	PROCESS	TEST	REWORK	MACHINE
Draw Parts		.5			
Robotic Assm.					.6
Manual Insert	1.0	.6			
Test/Inspect	.2		.2		
Rework				.5	
Solder					.1
Touch Up	.2	.1			
Other Steps		.2			
Shipping		.1			

TABLE 7: ROUTING AND STANDARD HOURS FOR "PRODUCT F" (6:V-63)

Given the work centers involved, the standard cost factors for each work center, and the standard hours per unit for each work center, the product cost for each work center can be computed. The following Table computes the product cost for the manual insert work center. All costs in the manual insert work center are applied based on total direct set-up and production hours (See Table 6). In this example, ". . .there are 61 labor hours (i.e., 1 set-up and 60 production for a lot of 100) and the total cost factor for [the manual insert] work center is $40.00 per labor-hour. The product of these factors is $2,440 or the sum of the individual increments" (6:II-64). Similar cost computations are also accomplished for the other work centers in the routing process.

DESCRIPTION	SET-UP HOURS	+	PRODUCTION HOURS	X	LOT SIZE	X	COST FACTOR	=	TOTAL INCREMENT
Set-up	1						$ 8.00		$ 8.00
Production			.6		100		8.00		480.00
Non-Prod.	1		.6		100		2.24		136.64
Conversion	1		.6		100		1.07		65.27
Other Direct	1		.6		100		4.67		284.87
Indirect	1		.6		100		9.33		569.13
Support	1		.6		100		13.36		814.96
Other Support	1		.6		100		1.33		81.13
Total	1		.6		100		40.00		2,440.00

TABLE 8: MANUAL INSERT COST COMPUTATION (6:V-65)

In the fourth step, product cost build-up is performed by adding all the work center computations as illustrated in Table 8 to calculate the total unit cost of producing Product F. Table 9 shows Product F's cost build-up.

DESCRIPTION	INCREMENTAL COSTS: MATERIAL, OTHER DIRECT/SUPPORT AND OTHER COSTS	LABOR: SET-UP PROD. NON-PROD	TOTAL INCREMENTAL	TOTAL (CUM)	UNIT COST
Draw Parts *	$28,660	$700	$29,360	$29,360	$294
Robotic Assm. *	4,610	0	4,610	33,970	340
Manual Insert					
Set-Up		$ 8			
Production		480			
Non-Prod.		137			
Conversion		65			
Other Direct	$ 285				
Indirect	569				
Support	815				
Other	81				
Total			2,440	36,410	364
Test/Inspect *	$ 359	$142	501	36,911	369
Shipping *	290	112	402	37,313	373
Other Costs *	1,023	409	1,432	38,745	387
Total Costs				$38,745	
Total Cost/Unit					$387
*Computations not illustrated					

TABLE 9: "PRODUCT F" COST BUILD-UP (6:V-66)

The fifth and final step of the ACMS cost estimating process involves calculating the intangibles such as risk, profit margin, etc.:

The last step in the cost estimating and product cost build-up process is a final comprehensive review. It is at this point that the overall organizational impact of the part/contract is evaluated. Items considered in this review include: effect of the estimating to production time lag, overall contract complexity,. . .effect of new capital improvements, and organization's experience with process/part being estimated (6:V-11).

PRODUCT COST CONTAINMENT

Industry management can manage product costs by way of an intricate management reporting system under ACMS. "The traditional objective of management reporting has been to provide timely data in a format that allows management to analyze performance as well as control costs. . .[these] management reports will concentrate on performance measurement in those areas defined as critical to the success of the business" (6:III-2).

As an example, one important way management contains cost is to closely monitor actual costs to the estimated costs developed using the pre-established standards. This is known as tracking the variance between actual and budgeted. Calculating variances provides management the insight to the inefficiencies within the factory and the detail to adjust the standards to more realistic rates for future estimating purposes (6:II-69).

Table 10 shows an operating report for the manual insert work center.

ACTUAL	MONTH BUDGET	DIFFERENCE	FINANCIAL
$ 30.00	$ 8.00	$ (22.00)	Set-Up Costs
488.00	480.00	(8.00)	Production Labor Costs
682.00	137.00	(545.00)	Non-Production Labor
125.00	65.00	(60.00)	Conversion Labor
1,325.00	690.00	(635.00)	Total Labor Costs
600.00	285.00	(315.00)	Other Direct Costs
600.00	285.00	(315.00)	Total Direct Costs
1,500.00	1,166.00	(334.00)	Indirect Costs
1,500.00	1,166.00	(334.00)	Total Indirect Costs
1,900.00	1,670.00	(230.00)	Support Costs
200.00	166.00	(34.00)	Other Support Costs
2,100.00	1,836.00	(264.00)	Total Support Costs
5,525.00	3,977.00	(1,548.00)	Net Operating Costs

TABLE 10: MANUAL INSERT MONTHLY OPERATING REPORT (6:II-75)

From this report, management is alerted to inefficiencies in the manual insert work center. Upon investigating, they may discover that five of the one hundred units were scrapped, that the operators took longer than the .6 hour standard to process a unit, that set-up time was two hours versus the standard one hour, or that due to an engineering change, a new work step had to be added to the unit's routing. Based on this information, management can take the proper steps to minimize the cost effect and adjust the standards, if appropriate, to more accurately estimate future business.

The ACMS uses numerous reports to inform and ". . .provide managers with the appropriate decision support tools" (6:III-1).

> To achieve this orientation, the management reporting system uses the following top-down approach to report design:
>
> 1. Identify critical success factors.
> 2. Develop indicators which will measure critical success factor performance.
> 3. Design a database system to collect and store the financial and operational data required to generate those indicators.
> 4. Create effective management reporting from that database which will monitor the status of critical success factor supported activities" (6:III-2).

INVESTMENT MANAGEMENT

The final key feature of the ACMS is the methodology employed to evaluate and track investment opportunities. The ACMS final report states:

> There is usually a limit to investment funds available to any manufacturing company. Internal competition between possible investment projects is to be expected. Therefore, it is important to establish a methodology to evaluate competing projects. A methodology or decision model provides a rational approach to allocating scarce investment resources. . .
>
> Any investment management approach should contain the steps listed:
>
> - Identify strategic and tactical goals;
> - Establish performance targets;
> - Identify costs and cost determinants;
> - Identify candidates technologies;
> - Analyze technology risk;
> - Evaluate alternative investment opportunities;
> - Select investment portfolio; and
> - Establish cost/benefit tracking systems (6:IX-1).

The remainder of this section will focus on how the ACMS approaches investment decisions by evaluating investment opportunities. For comparison purposes, refer back to Table 4 in Chapter 2.

The ACMS employs a Multiple Attribute Decision Model, ". . .that assists management in making cost-effective [investment] decisions" (6:IX-7). The crux of this model is a ranking system that allows management to compare different investment opportunities based on a predetermined set of criteria or factors. These factors, established by management, are divided into three categories: Financial-Quantitative, Non-Financial-Quantitative, and Qualitative (6:IX-7). The Model recommends the following factors for the above categories:

CATEGORY	FACTOR
- Financial-Quantitative	Operating Margin Net Present Value--NPV Level of Investment per time period Level of Savings per time period

> These factors were selected because they represent a minimal number of different views impacting "return on investment.". . . Net Present Value (NPV) provides the time-phased relationship of savings to investment. . .The level of investment and savings identify the magnitude of the cash flow streams, particularly the peak requirements relative to the company's financial constraints and/or requirements for change. The operating profit margin summarizes the operating costs relative to product value.

CATEGORY	FACTOR
- Non-Financial-Quantitative	Throughput Time Process Yield Schedule Time Lead Time

> Throughput time [is] the time in calendar weeks, from start to finish, of any internal task; process yield [is] the percent of good output (process), to total process output; schedule attainment [is] the percent of net good, actual output to total scheduled output at the scheduled due date; lead time [is] the time in calendar weeks from start to completion, of a task for external processes.

CATEGORY	FACTOR
- Qualitative	Process Basic R&D Technology Obsolescence Product Obsolescence

> . . .[These] measurements would indicate management direction on areas such as introducing a new product line or process and/or the need for basic R&D investment (6:IX-8 - IX-9).

Once the factors are determined, a numeric weight is assigned each factor as a measure of its relative importance. In addition to a weight, a numeric value is assigned to each factor based on a predetermined decision matrix (6:IX-7).

For example, if the critical factor is throughput time, a decision matrix might look like this (6:IX-7,IX-12):

Throughput Time	Value
0-2 Days	5
3-5 Days	4
6-9 Days	3
10-15 Days	2
Over 15 Days	1

After the weights and values have been assigned to each factor, a third numeric score, called a risk factor, is given to each. "The risk factor is the expected probability, at 95% confidence level, of achieving the critical factor value" (6:IX-8). This factor is assigned a value from 0 to 1.0. Put all together, the Multiple Attribute Decision Model provides management an analysis for each individual investment. The analysis contains an overall total number, such as 250 in the example below, which is then ranked with competing investments. Table 11 is an example of an investment analysis.

CRITICAL FACTOR	WEIGHT A	VALUE B	CONFIDENCE C	TOTAL (AxBxC)
1. Financial-Quantitative				
Net Present Value	20	0	.8	0
Operating Profit Margin	25	5	.7	88
Level of Investment	5	2	.7	7
Level of Savings	5	4	.7	14
2. Non-Financial-Quantitative				
Throughput Time	7	4	.9	25
Process Yield	15	4	.9	54
Schedule Attainment	3	4	1.0	12
Lead Time	5	3	1.0	15
3. Qualitative				
Process	5	3	1.0	15
Basic R&D	2	0		0
Technology Obsolescence	5	4	1.0	20
Product Obsolescence	3	0		0
TOTAL	100			250

TABLE 11: INVESTMENT MANAGEMENT MATRIX EXAMPLE (6:IX-15)

Compared to the strict return on investment/payback period approach as demonstrated in Chapter 2, Table 4, the ACMS model employs a much more

detailed and comprehensive approach. There are two keys to the ACMS model. The first key is the inclusion of non-financial and qualitative factors, in conjunction with financial considerations, in determining the relative worth of the investment. In many instances, the non-financial considerations are more important to the company's future success than the financial considerations. The second key is the portfolio approach where the entire factory is assessed for potential modernization and all investment opportunities are ranked and compared at the "big picture" level versus the individual project level. Bottom line: the ACMS approach systematically develops, analyzes, and ranks investment opportunities to allow for an informed, thus more intelligent investment decision.

SUMMARY

This chapter illustrates in a simplistic manner how a modern cost management system satisfies three fundamental, yet key, management needs: accurate product pricing/costing, product cost containment, and long-term investment decision making. Regarding product costing, the modern cost management system must answer the question: How much does the product cost? To answer this question, the modern system takes those common factory costs (overhead) and allocates them among the production work centers according to a logical base such as direct labor or machine hours. As the product proceeds through the factory, it assumes its fair share of those common factory costs. The bottom line is a product which is properly valued. Regarding cost containment, it is important that management tracks, on a real time basis, those significant cost drivers, cost factors, and determinants that shape the product cost. This is euphemistically called "keeping your finger on the pulse of the organization." The purpose of tracking these costs is to allow for timely and informed action. Regarding investment decisions, the key requirement is the development of a systematic approach for the entire factory to select the most beneficial investment portfolio based on financial and non-financial analyses. Once investments are implemented, it is equally important that benefits are tracked and reported to assist management in future investment decisions.

Chapter Four

ASSESSMENT

The defense aerospace industry environment is changing. These changes are a direct result of the automation revolution in computer controlled manufacturing equipment, shifting cost trends toward greater overhead costs and less direct labor costs, and changing Defense Department policies for profit, progress payments, and competition. As a result, cost management is fast becoming a priority issue within the defense aerospace industry. As more attention is being focused on cost management, industry leadership is realizing that the direct labor-based accounting systems fail to provide the information needed to price products, contain product cost escalation, and make long-term investment decisions. To compete and grow in the near-term and through the turn of the century, industry management must rethink their cost management practices.

The future defense aerospace environment will require at least four capabilities from the cost management system: the ability to identify and track significant costs, the ability to monitor machine costs as well as labor costs, the ability to accurately and timely report significant cost variances, and the ability to perform accurate investment analysis and cost benefit tracking. The ACMS conceptual model described in Chapter Three has these capabilities. It is now up to the defense aerospace industry to assess its cost management capabilities and update those systems that do not meet cost management needs.

Changing a cost management system is not an easy task; however, the implications not only to industry management but to the DOD acquisition process are significant. In an era of budget austerity, weapon system cost growth, close public and Congressional scrutiny of Defense spending, and media "horror stories," it is vital that the proper tools exist to plan and control defense industry costs. Due to the complexities of the issues and the close involvement of the DOD in approving contractor's accounting systems, it would best serve the interests of both industry and the DOD (including the Defense Contract Audit Agency) to work the issues jointly, and in a spirit of cooperation, to develop the most efficient guidelines for approval and implementation.

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